Modeling of Different Smallpox Scenarios

Presentation of the results and conclusions of a modeling exercise by a Working Group to the

Secretary's Advisory Council on Public Health Preparedness

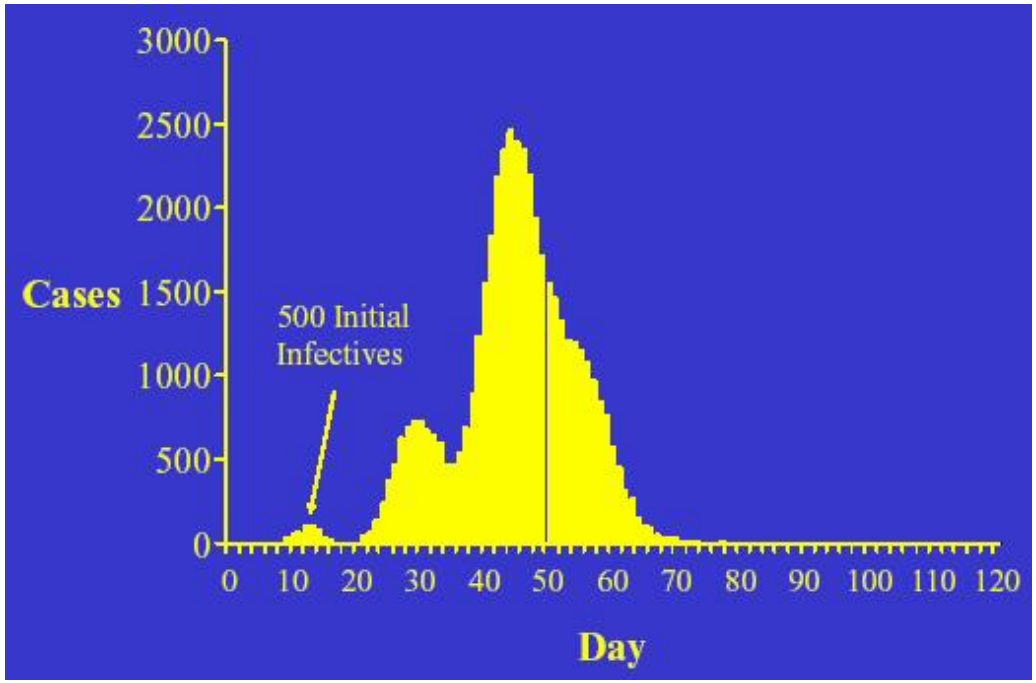
September 23, 2003
Arlington, Virginia

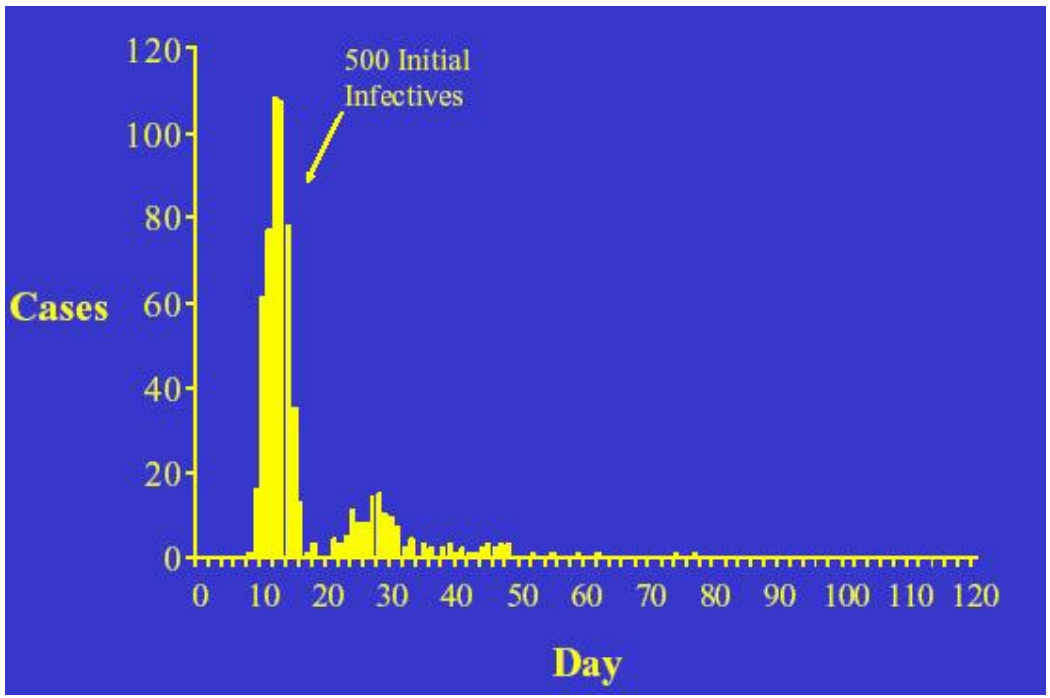
Scenario 1 – 10 adult cases in a population of 5,000-6,000 persons

Control Measures	Emory	Hopkins/ Brookings	CDC
None	5,649.7	5,473.8	1,045.9
None, but some background immunity	-	5,045.3	1,041.8
All surveillance & containment (S&C) measures	4.1	139.9	5.2
S&C plus 10% of hospital staff (HS) vaccinated	4.0	113.0	5.2
S&C plus 50% of HS vaccinated	3.9	128.0	5.2
S&C plus 10% HS, plus schools closed for 10 days, and 40% community vaccinated	Marginal benefit	89.0	5.2
S&C plus 50% HS, plus schools closed for 10 days, and 80% community vaccinated	Marginal benefit	62.2	5.2

Scenario 2 – 500 mixed cases in a population of 48,000-50,000 persons

Control Measures	Emory	Hopkins/ Brookings	CDC
None	44,788.5	46,643.8	27,306.3
None, but some background immunity	-	43,448.0	25,392.8
All surveillance & containment (S&C) measures	218.6	4,471.6	855.2
S&C plus 10% of hospital staff (HS) vaccinated	216.3	4,513.2	855.0
S&C plus 50% of HS vaccinated	210.0	4,576.8	854.9
S&C plus 10% HS, plus schools closed for 10 days, and 40% community vaccinated	199.7	3,035.2	809.9
S&C plus 50% HS, plus schools closed for 10 days, and 80% community vaccinated	191.0	2,398.4	767.3


3000
2500
2000
Cases 1500
1000
500
0
500 Initial
Infectives
0 10 20 30 40 50 60 70 80 90 100 110 120
Day


120
100
80
Cases 60
40
20
0
500 Initial
Infectives
0 10 20 30 40 50 60 70 80 90 100 110 120
Day

Conclusions of the Emory Model

"stochastic simulation" – Drs. Ira Longini and Betz Halloran

1. Surveillance and containment alone is sufficient to effectively contain even a large intentional smallpox release.
2. Given that surveillance and containment measures are taking place, there is relatively small marginal benefit in pre-vaccination of hospital workers or mass vaccination of the population after an outbreak begins.
3. In the absence of any interventions, the strongest controlling factor is simply people withdrawing to the home when they become ill.

Conclusions of the Hopkins/Brookings Model

"agent-based simulation" – Drs. Don Burke and Josh Epstein

This modeling exercise reveals that contact tracing and vaccination of household, workplace, and school contacts, along with prompt reactive vaccination of hospital workers and isolation of diagnosed cases, can control smallpox epidemics of 10 introduced cases in a town of 6,000, or 500 introduced cases in a town of 50,000. Reactive mass vaccination at the town level, when deployed in conjunction with contact tracing and control at the hospital, can have additional value in bringing an epidemic under control.

Conclusions of the CDC Model

"metapopulation differential equations" – Dr. John Glasser

Smallpox could be controlled by isolating cases, vaccinating contacts, and monitoring those vaccinated too long post-exposure to ensure protection. Such surveillance and containment strategies averted 83-99% of smallpox cases. Limiting prophylaxis to specially trained response teams and personnel who would care for patients at suitable facilities would minimize adverse reactions.

Conclusions

- Modeling of different smallpox scenarios has provided support for surveillance and containment (S&C) strategies rather than mass pre-vaccination of the general population.
- Such modeling has reinforced the urgent need for rapid detection and rapid implementation of S&C.
- Other very sensitive parameters that were not modeled include the potential presence of large numbers of “super-spreaders”, and how public panic may affect population movements and contact/exposure rates.
- The Working Group will need to develop uniform population contact/exposure rates that all models will use for future modeling exercises.
- All of the modeling efforts continue to be “works in progress”.